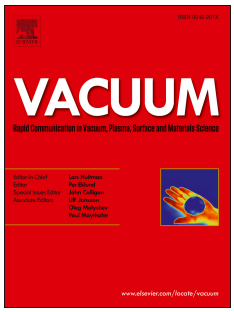
Accepted Manuscript



Deposition of large area uniform diamond films by microwave plasma CVD

J. Weng, F. Liu, L.W. Xiong, J.H. Wang, Q. Sun

PII: S0042-207X(17)31362-3

DOI: 10.1016/j.vacuum.2017.10.026

Reference: VAC 7655

To appear in: *Vacuum*

Received Date: 29 September 2017

Revised Date: 19 October 2017

Accepted Date: 19 October 2017

Please cite this article as: Weng J, Liu F, Xiong LW, Wang JH, Sun Q, Deposition of large area uniform diamond films by microwave plasma CVD, *Vacuum* (2017), doi: 10.1016/j.vacuum.2017.10.026.

Deposition of large area uniform diamond films by microwave plasma CVD

J. Weng[a], F. Liu[a,*], L.W. Xiong[a], J.H. Wang[a, b], Q. Sun[a]

[a]Key Laboratory of Plasma Chemistry and Advanced Materials of Hubei Province, Wuhan Institute of Technology, Wuhan 430205, China

[b]Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, China

Abstract

*Corresponding author. Tel.:+86-180-64129965; fax: +86-027-87194533

E-mail address: smile_204@163.com

Abstract

Diamond films with 70 mm in diameter were deposited on silicon substrates with $Ar/CH_4/H_2$ gas mixture, using microwave plasma chemical vapor deposition (MPCVD) technique. One designed water-cooling substrate stage was used to improve the uniformity of the surface temperature across the substrate. An uniform substrate surface temperature was obtained at the pressure of 10 kPa when the input microwave power was 5500 W. The condition of the plasma was diagnosed by optical emission spectrum (OES) and the grown diamond films were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD) and Raman spectroscopy. The results show that higher microwave power can further improve the uniformity of the temperature distribution across the substrate which in turn increases the uniformity of diamond film. And introducing more H_2 into $Ar/CH_4/H_2$ gas mixture at high microwave power is effective on the improvement of the quality and the decrease of the stress in the deposited diamond films. The diamond films with low average intrinsic stress of 0.32 GPa were finally deposited with introducing 100 sccm H_2 into $Ar/CH_4/H_2$ gas mixture at 5500 W.

Keywords: Large area diamond film; High microwave power; Uniformity; Microwave plasma; Chemical vapor deposition

1. Introduction

Chemical vapor deposition (CVD) diamond film has received considered attentions and presented wide applications due to its excellent properties such as extreme mechanical hardness, high thermal conductive, wide band gap, negative electron affinity and chemical inertness [1-4]. Over the last two decades, there are more and more emphases on scale-up CVD techniques in order to satisfy industry requirements [5, 6]. And the large area deposition of uniform diamond films by CVD method is considered as one of critical technological issues in the research and development (R&D) efforts [7, 8].

Among all CVD methods for the preparation of diamond films, hot filament CVD (HFCVD) and microwave plasma CVD (MPCVD) are the most widely used ones to grow diamond films with various area, morphology and quality. Compared to the MPCVD technique, HFCVD is an easier and relatively lower cost way being used to uniform deposit diamond coatings on large area substrates by controlling the main parameters of substrate and filament temperature, carbon concentration and total deposition pressure. However, metal impurities produced by high temperature filaments can hardly be avoided in the deposition possess. Whereas the plasma generated by electrodeless discharge is much purer which makes MPCVD become the most suitable technique to prepare high quality diamond films [9]. For industry application, one